Interview report for Cardiology ultrasound using AI* technology

Usefulness of diagnostic ultrasound systems using AI technology in the field of cardiovascular medicine

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Further improvements in AI technology to expand the clinical utilization of 3D echocardiography

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*Artificial Intelligence

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Introduction

Against the background of super-aging societies and large increases in the number of patients with heart failure, echocardiography must be further improved in terms of quality, efficiency, and operability. The diagnostic ultrasound system Aplio i-series / Prism Edition has been developed by using AI technology and incorporates a variety of advanced features such as automatic measurement functions, automatic plane detection, and Workflow Navigator. This system is designed to meet the exacting requirements of specialists in the field of cardiovascular medicine. We invited two physicians in the Department of Cardiology of Nagoya City University Hospital to discuss the clinical value and practical operability of Prism Edition at their hospital.

Efficient and accurate echocardiography to handle an increasing number of examination items

Please tell us how you use your diagnostic ultrasound systems and how you perform echocardiography in the Department of Cardiology of Nagoya City University Hospital.

Dr. Kikuchi: We have a total of 12 ultrasound systems for echocardiography. These include seven in the Central Clinical Laboratory, one each in the Cardiology ward and the Cardiac Care Unit (CCU), and three for research. On average, we perform about 35 echocardiography examinations per day in the Central Clinical Laboratory. Of these, 15-20 cases are sent to us by the Department of Cardiology (Fig. 1).

Dr. Wakami: The Department of Cardiology currently has 18 staff members, including those on parental leave. Their average age is around 40. We in the Department of Cardiology depend on echocardiography for the evaluation of cardiac function. Echocardiography plays a central role in our daily patient care conferences and serves as the key modality for assessing the constantly changing clinical condition of our patients. All our physicians are trained to evaluate the essential items for assessing cardiac function and heart failure.

What have you observed as recent trends in the target population for echocardiography?

Dr. Wakami: My impression is that we're performing echocardiography for more and more elderly patients with heart failure. They have a wide variety of primary medical conditions, but among the most common are valvular heart disease, ischemic heart disease, and exacerbation of heart failure due to tachycardic atrial fibrillation.

Figure 1 Echocardiography performed in the Central Clinical Laboratory.

Dr. Kikuchi: Our laboratory was renovated about three years ago. Before the renovation, we performed echocardiography for about 5,000 patients a year. But this year, we expected to examine about 8,000 patients, and the number is steadily increasing. We're also receiving more referrals from departments other than the Department of Cardiology. In some cases, echocardiography is used to check for any cardiac abnormalities in elderly patients before they undergo surgery. We've recently also seen an increase in periodic echocardiography for patients receiving chemotherapy. This is to monitor them for the development of cancer therapeutics-related cardiac dysfunction (CTRCD).

Dr. Wakami: In 2020, we opened oncology and cardiology outpatient clinics at our hospital. We've established a system in which echocardiography is performed before and after the administration of anticancer agents that could cause drug-induced myocardial damage. Patients are referred to us by various departments, such as hematology and breast surgery. In these patients, it's important to measure the left ventricular ejection fraction (LVEF) and also to evaluate myocardial strain. Based on the echocardiographic findings, we can provide valuable feedback to the physicians who are treating the patient's cancer.

What trends or issues do you see in echocardiography today?

Dr. Kikuchi: There are more items to be evaluated than in the past. Echocardiographic examinations are scheduled for about 30 minutes per patient, but it can be very difficult to evaluate all the required items within that time frame. With regard to left ventricular function, we used to measure the LVEF, but now we're often requested to perform more detailed evaluation of systolic function based on myocardial strain analysis. In addition, it's now common for us to evaluate left atrial, right atrial, and right ventricular function as well. Only a highly skilled ultrasound technician can complete such examinations within the scheduled time. If the technician is relatively inexperienced or if the case is particularly complicated, examinations tend to take longer than expected.

Dr. Wakami: Variation in the measurement results obtained by different examiners is another issue. When evaluating patients for drug-induced myocardial damage, we monitor the changes in LVEF over time. If there's large variation in the measurement results obtained by different examiners, it can lead to difficulties in patient management. That's why we conduct education and training during our daily patient care conferences and study meetings to minimize such variation.

Automatic measurement functions with high trace accuracy to minimize variation in the measurement results obtained by different examiners

What are your impressions of Aplio i-series / Prism Edition based on actually using the system? First of all, how do you like the automatic measurement functions?

Dr. Kikuchi: The automatic measurement functions include Auto E/A, Auto LVOT, Auto AV, and Auto TR. All of them seem to be very accurate. For example, even when it's difficult to determine where to obtain measurements in an image, the area selected by the system and the area I select based on my clinical experience usually match. Even in images that appear blurry, the system can obtain accurate measurements, so the examiner doesn't need to spend a lot of time repeating measurements or adjusting the settings. Image analysis is also performed very quickly, so the examiner can obtain measurements with a single touch and immediately move on to the next examination. This reduces the burden on the examiner. System operations are pretty much the same as in the previous model (without the automatic measurement functions), so we were able to start using Prism Edition without any difficulties.

Dr. Wakami: The automatic measurement functions are expected to reduce variation in the measurement results obtained by different examiners, which is an important issue. Even when monitoring patients with CTRCD, it's possible to obtain reproducible LVEF measurements. So I think we can more accurately evaluate changes in the patient's clinical condition.

Could you discuss the advantages of the automatic measurement functions in a bit more detail?

Dr. Wakami: Cardiac output is measured by calculating the velocity time integral (VTI) of the aortic ejection blood flow velocity waveform in the left ventricular outflow tract (LVOT) using the Doppler method. I feel that the system performs auto-tracing of the Doppler waveform accurately enough to satisfy even an experienced examiner.

Dr. Kikuchi: For example, LVOT flow velocity measurement can be performed using Auto LVOT (Fig. 2). Inexperienced examiners tend to misjudge the maximum velocity because they include the noise, which is seen as very thin peaks or spikes. Auto LVOT, on the other hand, ignores the noise and provides accurate maximum velocity measurements.

Figure 2 Auto LVOT traces a location which closely matches that selected by an experienced examiner, even when the waveform contains high levels of confusing noise.

What are your feelings about the Workflow Navigator function?

Dr. Kikuchi: Workflow Navigator (Fig. 3) is a function that displays instructions for various measurements based on the guidelines of the American Society of Echocardiography (ASE) and the European Association of Cardiovascular Imaging (EACVI)[1]. Because clear instructions are displayed on the screen, even inexperienced examiners can perform echocardiography and obtain all the required measurements without overlooking any of them.

Dr. Wakami: I think this function is also useful for educating physicians during their residency training as well as young physicians in other fields such as cardiology and internal medicine.

Figure 3 Workflow Navigator displays clear instructions for obtaining measurements and other items according to the specific clinical objectives based on ASE/EACVI guidelines.

2D WMT for all four chambers and 3D WMT with higher image quality

What are your impressions of the 2D Wall Motion Tracking (2D WMT) function?

Dr. Kikuchi: 2D WMT is based on the speckle tracking method. The endocardial contour is finely divided into segments of equal length, and the amount of strain is calculated from the changes in length at each point.
The previous model of the ultrasound system also had this function, but it was limited to the left ventricle. In the new Prism Edition, the left atrium, right ventricle, and right atrium can also be automatically traced and evaluated (Fig. 4).
In recent years, it's been recognized that left atrial function and right ventricular function are also important when performing cardiac function analysis. So the ability to analyze all these aspects of cardiac function in a short time is of great clinical value. The system also calculates a variety of indices such as the left ventricular volume, LVEF, left atrial volume, and left atrial emptying fraction (LAEF) at the same time as myocardial strain, which greatly improves examination efficiency. LAEF has been attracting attention as a useful predictor for the development of atrial fibrillation, and the evaluation of left atrial function has been found to be extremely useful.

Dr. Wakami: In terms of tracing accuracy, tracking at the cardiac apex is significantly improved compared to the previous model. In addition, when corrections are made after automatic tracking, the tracking position is adjusted according to the curved endocardial surface. This means that corrections can be made more easily and much more efficiently. In the past, manual corrections had to be made point by point.

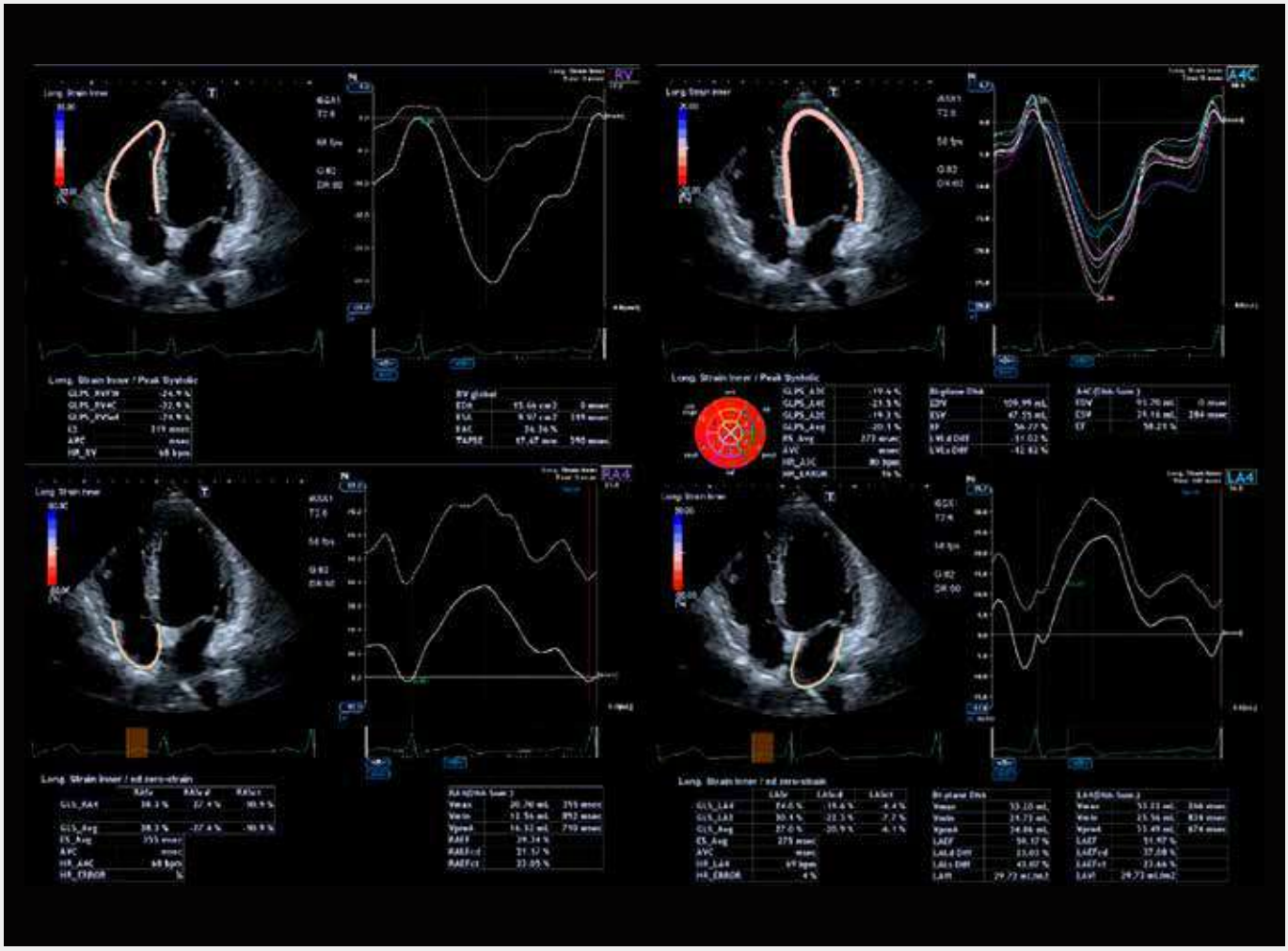

Figure 4 The 2D WMT function of Prism Edition can automatically detect the planes for each of the four chambers and display the initial contours.

What are your impressions of the 3D WMT function?

Dr. Kikuchi: 3D WMT (Fig. 5) avoids the problem of deviation of the analysis plane due to cardiac motion, which is one of the main drawbacks of 2D WMT. It allows us to evaluate cardiac function more accurately because cardiac motion is captured in three dimensions. I also feel that the image quality has been improved compared to the previous model. The tracking function is also outstanding, and I think it takes less time and effort to perform analysis.

Dr. Wakami: We're also glad that we don't need to align the axes. In the past, we had to manually set the long axis of the cardiac chamber and set a plane that was easy to analyze. But we don't need to do that anymore. I like that the measurement procedure has been simplified and can now be completed with almost a single touch.

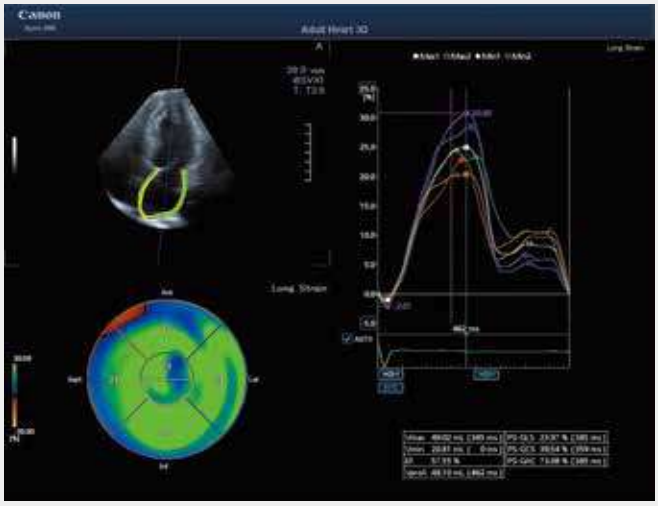

Figure 5 The 3D WMT function supports analysis of the left atrium in addition to the left and right ventricles.

Easy GLS measurement and left atrial function analysis, which have been attracting attention in recent years

Global longitudinal strain (GLS) and left atrial function have been attracting a great deal of attention recently. What are your impressions of Auto EF with GLS and Auto EF LA, which are functions for these types of analysis?

Dr. Kikuchi: GLS is a longitudinal systolic index for the entire left ventricular myocardium. It's attracting a lot of attention because it's considered more sensitive than LVEF as index of left ventricular function. The main advantage of Auto EF with GLS (Fig. 6) is that GLS measurements can be obtained during the normal course of an examination. GLS and LVEF can be measured at the same time using the 2D WMT function. At facilities that are just starting to measure GLS, it may be a good idea to introduce Auto EF with GLS because it's so easy to use.

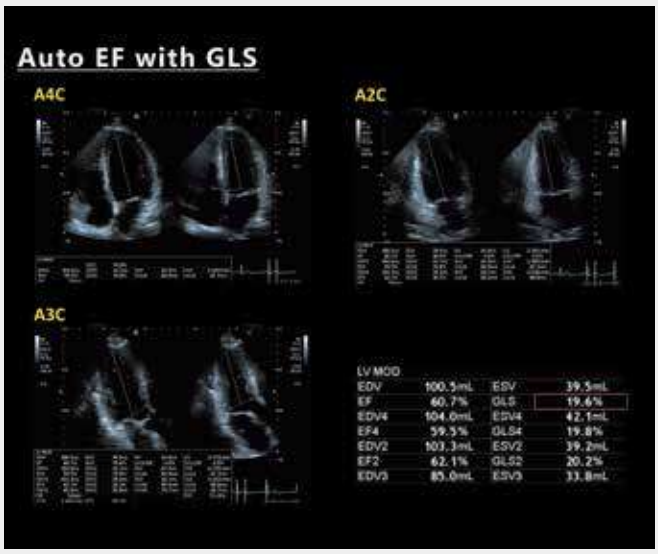

Figure 6 Auto EF with GLS allows GLS to be measured during the normal course of an examination, without the need to start up another application.

Dr. Wakami: The left atrial volume change rate and strain analysis have been reported to be useful for identifying left ventricular diastolic dysfunction[2]. The Auto EF LA function (Fig. 7) supports automatic measurements of the left atrium as well as the left ventricle, and it can obtain measurements of the left atrium alone or both the left atrium and left ventricle at the same time. In the past, we had to select the phase, measure the values, calculate the LAEF and LVEF, and assess left ventricular systolic function. Everything was done manually. But now, we can automatically obtain measurements of both the left atrium and left ventricle simultaneously.

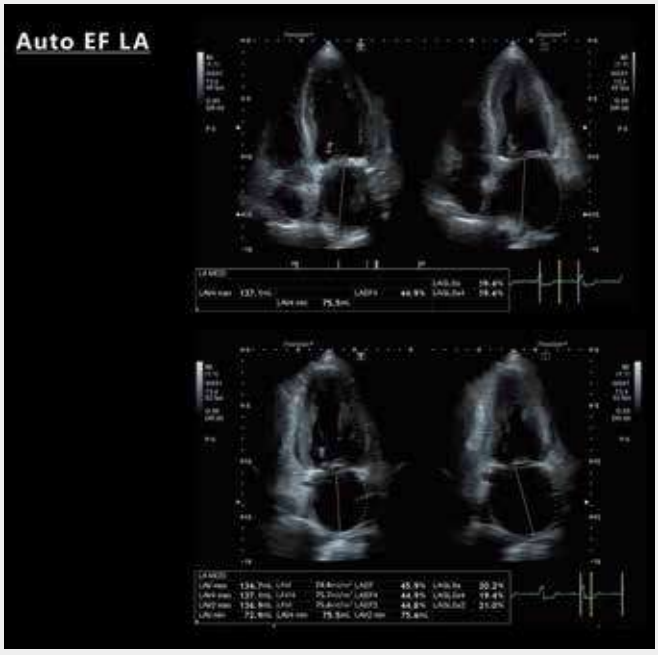

Figure 7 The Auto EF LA function allows automatic measurements of the left atrium as well as the left ventricle, and can be used to measure the left atrium alone or both the left atrium and left ventricle simultaneously.

High expectations that manufacturers will pursue higher image quality and more advanced AI technology

Please share with us your future expectations and hopes for ultrasound systems and manufacturers.

Dr. Kikuchi: Although echocardiography tends to be dependent on the skill of the examiner, advances in ultrasound systems have made it possible for relatively inexperienced examiners to obtain clear images. Also, the automatic measurement functions have greatly improved the reliability of examination results. In order to further increase reliability, it's my hope that ultrasound system manufacturers will work to provide even clearer images with higher resolution and develop more accurate automatic measurement technologies.

Dr. Wakami: The use of 3D echocardiography in routine clinical practice is still limited because reference values haven't been established yet. The accumulation of more clinical examination data should lead to the more precise and effective treatment of heart failure and cardiac disease in the future, so we would like to actively gather data using the automatic measurement functions of the Aplio i-series. It's my hope that manufacturers will continue to improve AI technology to support examiners and will develop new technologies to further reduce examination times in order to further expand the range of examination items.

Aplio i-series / Prism Edition

Further improvements in AI technologies to expand the clinical utilization of 3D echocardiography

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Global longitudinal strain (GLS) has matured into a clinically applicable evaluation method based on research into conditions such as cancer therapeutics-related cardiac dysfunction (CTRCD). Because GLS values may change by only a few percent as we follow them over time, good reproducibility must be ensured. It's also essential to minimize variation in the measurement results obtained by different examiners and to maximize reproducibility by employing automatic measurement methods developed by using AI. The number of examinations has been rising in recent years, and the number of measurement items may also increase substantially depending on the objectives of the examination. This means it's more important than ever to perform examinations quickly and efficiently. In this regard, the automatic measurement functions developed by using AI are ideal tools. They not only reduce examination times but also ensure high data accuracy. This trend is expected to continue into the future. The left atrium is currently attracting a great deal of attention, as it's been shown that its reservoir function strongly affects exercise tolerance and the prognosis of patients with heart failure[3,4]. Examinations of the left atrium tend to be extremely time-consuming because the chamber has a very complicated shape, and variation in the measurement results obtained by different examiners is an important issue. If these challenges can be overcome by employing automatic measurement functions developed by using AI, we will have cleared a major hurdle in the introduction and widespread acceptance of such diagnostic imaging systems. It's my belief that the left atrial reservoir function will be recognized as a useful index for assessing left ventricular diastolic function in the future. I expect that Canon will continue to introduce a wide variety of technological innovations to meet the needs of medical professionals in clinical practice, including automatic measurement functions with good reproducibility and high accuracy.

* Please note that the comments presented above are the views of the speakers.

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https://global.medical.canon

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